ERF 2020

26TH Annual Conference

The Impact of Socio-economic Development and Political Instability on the Ecological Footprint in the MENA Region: Evidence from Panel VAR Estimations

Mouyad Alsamara and Zouhair Mrabet

ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

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ABSTRACT

Using a sample of 16 countries from the MENA region for the period 1990 to 2016 and the Panel Vector Autoregressive (PVAR) methodology, we find a strong negative relationship between the ecological footprint and the human development index (HDI). Interestingly, our findings reveal that this relationship is inverted U-shaped where non-oil countries in the MENA region did not reach the turning level yet whereas oil-producing countries are now at a stage of development where further increases in HDI will reduce the ecological footprint. Moreover, we show that the political instability following the 2011 Arab uprising has shifted the turning point upward. Accordingly, because of the uprising, MENA region countries require a higher level of HDI to start experiencing environmental improvements. These findings are of paramount importance with several policy implications in exploring potential pathways to sustainable development.

Keywords: Ecological footprint, Economic development, Energy use, Urbanization, Trade openness, Political instability

JEL classification: F18, O47, C23, Q53

1. Introduction

Nowadays, sustainable development where current economic and social prosperity does not compromise the available resources for future generations is of utmost importance to policymakers. Indeed, the recent climate changes, global warming, and environmental degradation at large have resulted in adverse effects threatening the living of human beings and other species (Naz et al., 2019; Bello et al., 2018). In addition, since the beginning of the industrial revolution, the exaggerated use of pollutant natural resources to fuel the global economy and satisfy a continuously increasing demand was such that these priorities came at the expense of environmental considerations. However, in the midst of the serious and alarming environmental concerns, a glimmer of hope emerges from a strand of literature advocating the existence of an Environment Kuznets Curve (EKC) hypothesis. Within this framework, the relationship between the environmental degradation and the income level is inverted U-shaped (Destek and Sarkodie, 2019; Hdom, 2019; Churchill et al., 2018; Alsamara et al., 2018; Zoundi, 2017; Aşıcı and Acar, 2016). Accordingly, as the income per capita increases, countries will eventually reach a level of development where environmental enhancements will be achieved. At this stage, the country's economy would move toward less pollutant activities, like services, and therefore harmful emissions are reduced. The supporters of the EKC hypothesis claim that economic development may ultimately represent a viable solution to environmental enhancements and constitutes, in the long-run, a promising avenue for policymakers to increase national wealth without compromising the environment quality.

However, the traditional EKC literature suffers from a serious shortcoming. Indeed, this literature focuses solely on the GDP per capita as a key variable to achieve environmental enhancements and ignores the social dimension despite that it is considered as one of the pillars of sustainable development (Dong et al., 2018; Bekun et al., 2019). At the same time, the theoretical and empirical literature that addresses this shortcoming by using broader indicators of development combining the economic and social perspectives is relatively scant with very few exceptions (Jha and Murthy, 2003; Costantini and Monni, 2008; Omri et al., 2019). We postulate in this paper that sustainable development can occur by improving the social dimension along with the income dimension. To do so, this paper employs the Human Developments Index (HDI hereafter) instead of the GDP per capita in a modified EKC hypothesis (Costantini and Monni, 2008) and shows that countries with better socio-economic conditions will ultimately experience environmental enhancements. We use the HDI because it tracks the country's achievements in terms of durability (life expectancy rate), education accessibility (literacy rate), and income level (GDP per capita) (UNDP, 2008). Accordingly, the HDI is an intuitive measure of whether individuals, within a country, enjoy a long, intellectual, and productive life. It directly affects the human demand on the environment since a better education and life expectancy rates are usually associated with larger investments in infrastructure, such as schools and healthcare facilities, which in turn require a higher GDP and may lead to environment deterioration especially in developing countries.

We measure the impact of HDI on the Ecological Footprint (EF hereafter). The EF is a proxy for environmental sustainability and measures how excessive is the human demand on the available natural resources (Mancini et al., 2016; Siche et al., 2008). It includes several components such as carbon footprint, cropland, grazing land, forest products, built-up-land, and fishing grounds (Ulucak and Lin, 2017; Danish et al., 2019). This indicator is of great importance to evaluate the ecological sustainability as well as its balance by comparing the human demand to the available supply of natural resources (Redefining Progress, 2004). Hence, this paper studies the effects of an augmented version of GDP (HDI) on an augmented measure of environmental degradation (EF).

In investigating the EF – HDI relation, we choose a sample of countries from the Middle East and North Africa[1] (MENA hereafter) region. One of the main motivations of this choice is that several MENA countries played a significant role in producing and exporting oil, gas and other natural resources worldwide. Following the colonial era, these countries were lagging behind in terms of socio-economic development. To catch up, they had to overuse their natural resources and became not only the largest producers of oil and gas but also large consumers of these resources. The race towards improving the socio-economic levels is still a priority in the MENA region exerting an enormous pressure on the environment and the use of natural resources. It follows that this group of countries represents a natural laboratory to investigate the EF – HDI relationship, in particular because of their access to considerable reserves of pollutant fossil energy at relatively low cost. This is the case for instance for the Gulf Cooperation Countries (GCC) which have been recently ranked between medium and high in terms of human development with a score near 0.8 (WDI 2017 data). Unfortunately, these excellent scores were associated with relatively fast environmental degradation and with an increasing pollution levels (Omri et al., 2015). It appears, therefore, that the human development improvements in the MENA region countries were achieved through a continuous but progressive demand on natural resources that harm the ecosystems (Sakmar et al., 2011).

The environment – development dilemma for this group of countries is even more complex when one takes into consideration the serious challenges regarding the conflicts and political instability

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[1] This paper includes 16 countries from the MENA region: Algeria, Jordan, Egypt, Iraq, Libya, Morocco, Oman, Sudan, Syria, Saudi Arabia, Tunisia Yemen, Qatar, United Arab Emirates, Iran, and Turkey.

in the region. Indeed, political instability may slow down growth leading to substantial delays in economic and environmental enhancements. In this respect, MENA countries stand at a crossroads in the aftermath of the Arab uprising of 2011 where it would be of interest to investigate if the occurrence of such major events have an impact on the linkage between human development and environment degradation. It would be also of high importance to study possible remedies and pathways leading to sustainable development.

Our results highlight some novel and interesting patterns. First, using the PVAR estimation, the variance decomposition, and the impulse response functions, we show that the ecological footprint is strongly affected by the level of the human development index. Second, we find that this effect is different when the sample is split into oil-producing and non-oil countries[2] suggesting the existence of a nonlinear relationship between EF –HDI. Our findings therefore suggest that when the level of HDI is low, any efforts to increase it will lead to environmental deterioration. However, beyond a critical threshold of HDI, countries can experience environmental enhancements. Hence an inverted U-shaped relationship between EF and HDI. Additionally, we find that other factors affect the EF including trade, energy consumption, and urbanization. Because trade, energy consumption, and urbanization cannot be easily handled by policymakers to control pollution, the HDI emerges as a strong tool to reduce the adverse effects on the environment. Finally, we find that the 2011 Arab uprising has led to a shift in the turning point in the EF- HDI relationship. Thus, after the uprising, countries need to achieve a higher level of HDI to start experiencing environmental improvements.

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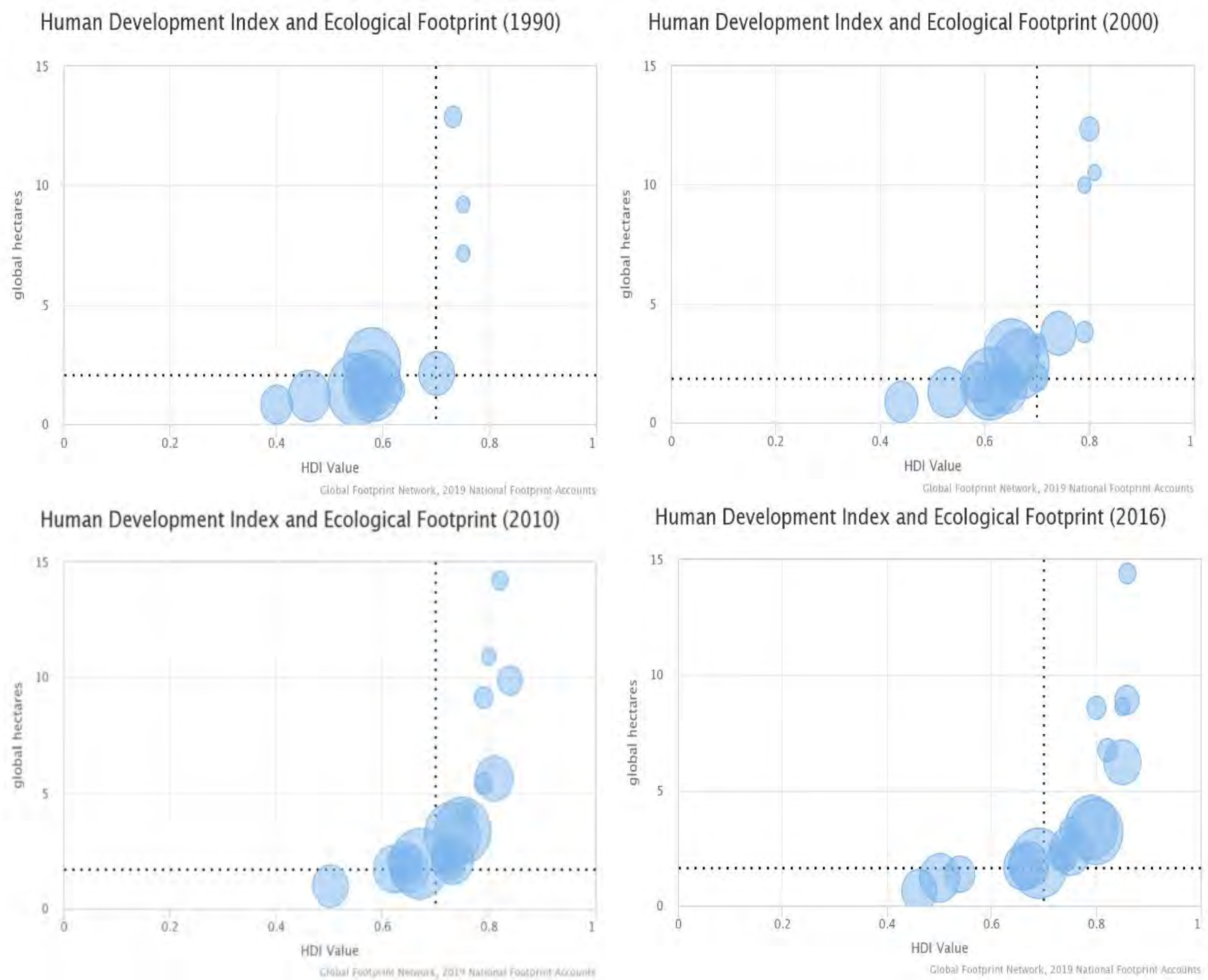
[2] Oil producing countries are Algeria, Bahrain, Iran, Iraq, Libya, Qatar, Saudi, and UAE. Non-oil countries are Jordan, Morocco, Sudan, Syria, Tunisia, Turkey, Egypt, and Yemen.

The remainder of the paper is organized as follows. Section 2 presents a brief overview of the EF – HDI relationship in the MENA region. Section 3 lays out a brief literature review. Section 4 describes the data and the estimation methodology. Section 5 discusses the results. Finally, Section 6 concludes and provides policy implications.

2. Brief overview of the EF – HDI relationship in the MENA region

As discussed above, the MENA region offers an interesting framework to study the EF- HDI relationship. Figure 1 shows four snapshots for the relationship between EF and HDI in this region in four different periods: 1990, 2000, 2010, and 2016. It is clear in Figure 1 that the HDI has been improving from period to period for this group of countries. However, Figure 1 points to an alarming co-movement between the HDI and the EF. Indeed, it is evident that the increase in the HDI and the overall level of wellbeing was associated with an increase in EF. Hence, the EF increase is a reflection of the environmental degradation resulting form growing efforts in the MENA countries to sustain and enhance their human development. Showing the existence of a causality between these variables and how this relationship changed over time due, for instance, to political events like the Arab uprising, constitutes the main research question that this paper aims to address.

Figure 1: The patterns of HDI and EF developments in 1990, 2000, 2010 and 2016



Moreover, a careful review of Figure 1 highlights several interesting trends in the EF – HDI relationship. On the one hand, the year 2016 is characterized by relatively similar patterns compared to what was observed in 2010 for some countries such as Egypt, Tunisia, Jordan, and Algeria. On the other hand, other MENA region countries have experienced a substantial decline in their levels of HDI and EF. This includes for instance Sudan, Syria, Libya, and Yemen. It is interesting that most of the countries in these groups were concerned or directly impacted by the

Arab uprising. However, the outcome of the uprising was substantially different for the countries belonging to these groups. We therefore investigate the effects of the 2011 Arab uprising on the EF and on the HDI to unveil hidden relationships.

Figure 1 also shows that other countries have witnessed a slight increase in both HDI and EF indicators including Saudi Arabia, Qatar, Oman, and Turkey. Only few countries have succeeded in reducing the EF while improving the HDI. These countries are Morocco, the United Arab Emirates, Kuwait, and Bahrain.

It is evident from the above discussion that the EF – HDI relationship in the MENA countries comprises several patterns that need to be investigated. In doing so, this paper contributes to the existing literature by examining the EKC hypothesis in the MENA region with a special emphasis on the effects of the 2011 Arab uprising. Additionally, this paper uses an innovative econometric approach to explore the potential pathways of EF – HDI nexus with important policy implications.

3. Literature Review

The literature offers a vast range of theoretical and empirical studies on the interaction between economic and environmental aspects (see Table 1). In this literature, the EKC hypothesis stands as an important contribution to explore the relationship between the environmental degradation and the income level as well as the associated challenges in achieving a sustained development.

Economists were among the first to use the linkage between the income inequalities measured by the per capita GDP (Kuznets ,1955) to investigate the relationship between economic development and environmental deterioration. Grossman and Krueger (1991) found that, in the first stages of development within a country, economic growth is usually associated with a fast environmental degradation given that energy greedy industries are usually promoted. Beyond a certain level of wealth, countries start experiencing environment improvements. This pattern suggests an inverted U-shaped relationship designated as the EKC hypothesis.

The EKC hypothesis has since generated a large empirical work to check its validity (Fodha and Zaghdoud, 2010; Shahbaz et al., 2015; Uddin et al., 2016; Mrabet and Alsamara, 2017; Mrabet et al., 2017; Alsamara et al., 2018; Pata, 2018; Dong et al., 2018; Bekun et al., 2019). Most of these studies used either individual countries, regions, or groups of countries. Additionally, they employed various econometric methods and estimation techniques. Many of these studies have provided an evidence on the long-run relationship between GDP growth, income level, or real GDP and CO_2 emissions but their overall findings are mixed at best and vary according to the methodology used, the time period examined, and the selected variables to be included in the model.

Table 1: Summary of the existent empirical studies of the EKC hypothesis

Author	Period	Country / Region	Empirical	Environmental	The validity of the EKC hypothesis
Individual Countries					
Shahbaz et al., (2019)	1964-2016	Vietnam	ARDL	CO_2	No (N-shaped)
Naz et al., (2019)	1975–2016	Pakistan	Least regression	CO_2	No
Bekun et al., (2019)	1960- 2016	South Africa	ARDL	CO_2	Yes
Dong et al., (2018)	1965-2016	China	ARDL	CO_2	Yes
Bello et al., (2018)	1971-2016	Malaysia	VECM	EF and CO_2	Yes
Salahuddin et al. (2018)	1980-2013	Kuwait	ARDL	CO_2	Yes
Shahbaz et al., (2018)	1955-2016	France	Bootstrap bounds	CO_2	Yes
Sarkodie and Strezov (2018)	1971- 2013	Australia, China, Ghana and the USA		CO2	Yes
Riti et al., (2017)	1970-2015	China	ARDL, FMLOS	CO_2	Yes
Solarin et al., (2017)	1965-2013	India and China	ARDL	CO_2	Yes
Mrabet and Alsamara (2017)	1980-2011	Qatar	ARDL	CO_2	Yes
Shahbaz et al., (2016)	1971-2012	19 African countries	ARDL	CO_2	Yes (for six countries)
Wang et al., (2016)	1990-2012	China	VECM	CO_2	Yes
Bakhsh et al., (2017)	1980-2014	Pakistan	3SLS model	CO_2	No
Javid and Sharif (2016)	1972-2013	Pakistan	bound F-test		
Mrabet et al., (2016)	1980-2011	Qatar	ARDL	EF	Yes
Al-Mulali et al., (2015)a	1980-2011	Vietnam	ARDL	CO_2	No
Onafowora and Owoye (2014)	1970-2010	8 countries	ARDL	CO_2	Yes (for Japan and south Korea)
Shahbaz et al., (2014)	1971-2010	Tunisia	ARDL and VECM	CO_2	Yes
Shahbaz et al., (2013)	1980-2010	Romania	ARDL	CO_2	Yes
Nasir and Rehman (2011)	1972-2008	Pakistan	Johansen cointegration	CO_2	Yes
Jalil and Mahmud (2009)	1975-2005	China	ARDL	CO_2	Yes
Panel of countries					
Destek and Sinha (2020).	1980-2014	24 OECD countries	AMG	EF	No
Destek and Sarkodie (2019).	1977-2013	11 industry countries	AMG	EF	Yes
Hdom (2019)	1980-2010	South America	ARDL	CO_2	No
Churchill et al., (2018)	1870-2014	20 OECD countries	AMG	CO_2	Yes
Alsamara et al., (2018)	1980-2017	GCC Countries	GMM and PMG	CO_2 and SO_2	Yes
Shuai et al., (2017)	1960-2011	164 countries	OLS		Yes
Zoundi (2017)	1980-2012	25 African countries	panel cointegration	CO_2	No
Charfeddine and Mrabet (2017)	1975-2007	15 MENA countries	panel cointegration	EF	Yes
Özokcu and Özdemir (2017)	1980-2010	26 OECD and 52 emerging countries	Panel regression	CO_2	No (N shaped)
Aşıcı and Acar (2016).	2004-2008	116 countries	Panel regression	EF	Yes
Brahmasrene and Lee (2017).		South-East Asia			
Al-Mulali and Ozturk (2016)	1990-2012	27 advanced economies	FMOLS	CO_2	Yes
Al-Mulali et al., (2016)	1980-2010	Seven regions	DOLS	CO_2	Yes
Bilgili et al., (2016).	1977–2010	17 OECD countries	FMOLS and DOLS	CO_2	Yes
Abid (2016)	1996-2010	25 Sub-Saharan Africa	GMM	CO_2	No
Jebli (2016)	1980-2010	25 OECD countries	FMOLS	CO_2	Yes
Apergis and Ozturk (2015)	1990–2011	14 Asian countries	GMM Method	CO_2	Yes
Wang et al., (2015)	1995-2011	Cities in China	Panel regression	CO_2	No
Baek (2015)	1960-2010	Arctic Countries	ARDL	CO_2	Yes
Salahuddin et al. (2015)	1980-2012	GCC countries	Fully Modified OLS	CO_2	No
Kasman and Duman (2015)	1992-2010	EU Countries	Panel regression	CO_2	Yes
Omri et al. (2015)	1990-2011	12 MENA	Panel regression	CO_2	Yes
AL-Mulali et al. (2015)b	1980-2008	93 countries	GMM	EF	Yes (upper middle and high-income countries)
Lopez-Menendez et al. (2014)	1996-2010	27 countries	Panel cointegration	CO_2	No
Ibrahim et al. (2014)	2000-2008	69 countries	GMM		No
Farhani et al. (2014)	1990-2010	10 MENA	Fully Modified OLS	CO_2	Yes
Kivyiro and Arminen (2014)	1971-2009	Sub-Saharan African	ARDL	CO_2	Yes
Halkos, G.E. (2011)	36 years	32 countries	Panel regression		No
Narayan and Narayan (2010).	1980-2004	43 developing countries	panel cointegration	CO_2	Yes
Galeotti et al. (2006)	1960-1998	OECD countries	Cointegration test	CO_2	Yes
Permann and Stern (2003)	1960-1990	74 countries	Panel regression	CO_2	Yes

Table 1 reports a detailed summary of the existent literature on the EKC hypothesis. It is striking that most of the studies in this table incorporated the CO_2 emissions as a proxy for environment degradation and the GDP per capita as a proxy for economic growth. Furthermore, several studies included augmented versions of the original EKC model where additional variables are added to the regression.

These additional variables include among others energy use, trade, financial development, urbanization, population, and foreign direct investment (Nasir and Rehman, 2011; Shahbaz et al., 2013; Shahbaz et al., 2014; Al-Mulali et al., 2015; Wang et al., 2016; Churchill et al., 2018; Alola et al., 2019). When analyzing the results of this literature, we notice that the findings related to the additional variables are mixed. For instance, Nasir and Rehman (2011) find that both energy consumption and trade have a positive impact on environmental degradation in Pakistan. Shahbaz et al. (2013) and Özokcu and Özdemir (2017) show that energy consumption positively influence the environment quality in 26 OECD countries and 52 emerging countries. In contrast, Bilgili et al. (2016) and Zoundi (2017) report that renewable energy consumption reduces environment pollution in 17 OECD countries and 25 African countries, respectively. In another study, Churchill et al. (2018) found that trade, financial development, and population have a positive impact on environmental degradation in 20 OCED countries while Solarin et al. (2017) revealed that urbanization have a positive impact on environmental degradation. The same authors report that hydroelectricity negatively influences the environmental quality in China and India. Brahmasrene and Lee (2017) document similar results for the South-East Asia region. Finally, according to Shahbaz et al. (2019), foreign direct investment and urbanization reduce the environmental degradation and improve the overall environment conditions in Vietnam.

However, despite the abundant empirical work investigating the interaction between the economic and environmental perspectives, these studies still have several shortcomings that our paper attempts to address**. First**, most of these studies have employed the income level, real GDP, or GDP per capita as a proxy for the level of development (Acaravci and Ozturk, 2010; Wang et al., 2011; Arouri et al., 2012; Wang et al., 2016; Mrabet et al., 2017; Bello, et al., 2018). While, the level of income, real GDP or GDP per capita are good indictors of the economy size and its performance, they fall short of reflecting the overall human development and the individual's wellbeing. To remedy to this shortcoming, this paper uses instead the HDI to measure the level of economic and social development (Jha and Murthy, 2003). **Second**, by considering the CO_2 or the SO_2 emissions as proxies for the environment degradation (Sun, 1999; Lantz and Feng, 2006; Miah et al., 2010; Kaika and Zervas, 2013; Salahuddin et al., 2015; Wang et al., 2016; Churchill et al., 2018), researchers will underestimate the effects of economic growth on the environment. Indeed, CO_2 and SO_2 emissions reflect a thin portion of the overall environmental damage due to human's activities (Al-Mulali et al., 2015b; Destek and Sarkodie, 2019). Hence, more studies are now employing the Ecological Footprint as a comprehensive measure of the environment quality. Following this literature, this paper employs the EF as a proxy for environmental degradation and the increasing demand on the relatively limited natural resources. EF represents a better measure to examine the interaction between the economic, social, and environmental aspects needed for a sustainable development (Jeremic et al., 2011). It is intriguing that despite its comprehensive feature, very few studies have investigated the relationship between the EF and real GDP or economic growth. These studies include for instance, Destek and Sarkodie (2019) who used an augmented mean group method and showed the existence of an inverted U-shaped relationship between the EF and economic growth in 11 newly industrialized countries. Aşıcı and Acar (2016) report similar results when they examine the EKC hypothesis within the EF framework. In the same vein, Al-Mulali et al., (2015 b) examine the EKC hypothesis in 93 countries using the GMM method. Their results reveal that the inverted U-shaped relationship between the EF and the GDP growth exists only in the upper-middle and high-income countries. On the contrary, the EKC hypothesis does not hold for low and lower-middle income countries due to the use of inefficient and old technologies.

Third, studies focusing on the level of the EKC turning points and turning years in different countries and regions is scant (Shuai et al., 2017; Du and Xie 2019; Jiang et al., 2019). More importantly, the research on the factors affecting these turning points, turning years, and the speed at which they converge is relatively inexistent with some few exceptions. For instance, Jiang et al. (2019) indicate that international trade delays the benefits of global CO_2 emission decays. Our paper adds to this literature by studying the effects of political events, namely the 2011 Arab uprising, on the turning point levels to unveil their impact on achieving a sustainable development in the region.

Lastly, many studies highlight the nonstationary feature of the EF indicator and advocate therefore that any shocks affecting the EF will be permanent (Ulucak and Lin, 2017; Solarin and Bello, 2018; Yilanci et al., 2019). Using a large sample, Solarin and Bello (2018) find that the EF is nonstationary in 96 countries. If this is the case, understanding the EF determinants and analyzing their potential effects on the environment quality is essential to achieve a sustainable development where a country can enjoy larger wealth within a safe living environment. In this paper, we contribute to this literature by thoroughly analyzing the impact of different shocks on the EF. The outcome of this analysis can be used to develop potential national and regional policies that promote sustainable development.

4. Data and empirical methodology:

4.1 Data and variables description

In this study, we use several variables to explore the relationship between environmental degradation and socioeconomic development. For the dependent variable, we use the Ecological Footprint as a comprehensive measure to assess the deterioration of the environment. It includes several components such as carbon footprint, cropland, grazing land, forest products, built-up-land, and fishing grounds (Ulucak and Lin, 2017; Danish et al., 2019). The explanatory variables include the Human Development Index, trade, energy consumption, and urbanization (see Table 2). All variables are expressed in logs. The data is extracted from the World Bank Development Indicators (WDI) and the Global Footprint Network databases. Our sample includes 16 countries form the MENA region over the period 1990-2016.

Table 2: Variables description

This table contains the description of all variables included in the estimations. It also provides the definitions, units, expected impact on the EF, and the data source.

Variable	Variable name	Definition	Units	Expected impact of EF	Data source
EF	Ecological Footprint per person	According to Global Footprint Network, the Ecological Footprint measures the ecological assets needed to produce the natural resources a population consumes and the required resources to absorb its waste.	Global hectares		Global footprint network. http://data.footprintnetwork.org/
HDI	Human Development Index	The HDI measures the development of a country in terms of income, education, and health.	Between 0 and 1 where 0 is low human development and 1 is high human development	+	United National Development Programme
EC	Energy consumption	It includes the consumption of petroleum products, natural gas, electricity, and combustible renewable and waste.	Tons of oil equivalent	+	Word development Indicators
T	Trade	Trade is equal to the sum of exports and imports of goods and services divided by GDP	Percentage of GDP	+/-	Word development Indicators
UB	Urbanization	According to the World Bank, urban population is defined as people living in urban areas as defined by national statistical offices	Share of urban population in total population	+/ –	Word development Indicators

4.2 Estimation methodology

To study the EF – HDI relationship in the MENA region, this paper employs the PVAR methodology to examine the dynamic and endogenous relations between ecological footprint, HDI, trade, energy consumption, and urbanization in the MENA countries. The PVAR approach combines several characteristics that make it particularly appropriate for our analysis. First, this method has the advantage to tackle any problems of small time-series data. Second, it allows the presence of heterogeneous individual effects in the model. This feature is particularly important in our case, as there exists large differences among the MENA countries in terms of EF and HDI.

Third, this method takes into consideration the presence of heteroscedasticity in the data. Fourth, the PVAR method uses a system of equation where all variables are treated as endogenous. Within this estimation technique, the effects of orthogonal shocks can be evaluated, and the impact of a shock of one variable on other variables can be studied.

In this study, we estimate the following model:

$$Y_{it} = B_0 + \sum_{i=1}^{p} B_i Y_{i,t-i} + \delta_i + \epsilon_{it} \quad (1)$$

where Y_i is a vector that includes the change in the following five dependent variables under investigation: ecological footprint (ΔEF), human development index (ΔHDI), trade (ΔT), energy consumption (ΔEC), and Urbanization (ΔUB). B_i is a vector of the coefficients to be estimated. δ_i captures the country specific effects. ϵ_{it} denotes the idiosyncratic errors.

The main challenge in estimating equation (1) is the presence of a correlation between δ_i and the regressors induced by the lags of the dependent variables in the right side of the equation. To overcome this issue, we use the forward mean-differencing technique instead of the fixed-effects estimator, which preserves the orthogonality between the transformed and lagged regressors. Therefore, the lagged regressors can be used as instruments in order to obtain more consistent estimates when using the Generalized Method of Moments (GMM).

Before estimating equation (1) using the PVAR model, it is crucial to perform the unit root tests for all variables in order to avoid the problem of spurious regressions.The literature offers two categories of unit root tests for panel data. The first includes the LLC test, the Breitung test, and the Hadri test. All of these procedures assume that all cross-section series have a common unit-root process. The second category of tests assumes instead that each cross-section series has its individual unit-root. This category includes the IPS test, the Fisher ADF test, and the Fisher PP test. In our empirical analysis, we apply the IPS test given that MENA counties are characterized by substantial differences in terms of ecological footprints, HDI levels, trade, energy consumption, and urbanization. If the IPS test reveals that variables are integrated of order 1 (i.e. I(1)), then we need to check if there exists a long-run relationship between variables via the Pedroni (2004) cointegration test. This test accounts for country heterogeneity including the country size. Pedroni (2004) propose seven tests of cointegration to explore the long-run co-movements in heterogeneous panels. These cointegration tests are classified into two subgroups. The first includes the "within dimension" tests and involves four tests that provide the panel cointegration statistic. The second subgroup is known as the "between dimension" with three tests that provide the group mean panel cointegration statistic.

The results of IPS unit root tests for the full sample and the two subsamples of oil-producing and non-oil countries are reported in Table 3. It is clear from the results in Table 3 that while all series are not stationary in level (expect for urbanization), their first-difference are stationary as we reject the null hypothesis of the presence of unit roots at the 1 percent significance level.

Table 3: Panel unit root test Im, Peseran and Shin (IPS)

We perform the IPS unit-root test which assumes that each cross-section series has its individual unit-root process. The test is done for all series in level and in first-difference. ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively.

	Level		Difference	
	IPS test	p-value	IPS test	p-value
Full sample				
LEF	-0.15	0.56	-19.18***	0.000
LHDI	-1.16	0.12	-6.99***	0.001
LEC	0.87	0.21	-8.83***	0.000
LT	-0.85	0.19	-8.5***	0.000
LUB	-0.10	0.45	-11.01***	0.000
Oil-producing countries				
LEF	0.04	0.51	-7.83***	0.000
LHDI	1.11	0.86	-5.28***	0.001
LEC	0.22	0.59	-5.21***	0.000
LT	-0.11	0.45	-4.56***	0.000
LUB	-0.8	0.21	-12.16***	0.000
Non-oil countries				
LEF	0.38	0.64	-8.45***	0.000
LHDI	4.85	0.9	-3.25***	0.001
LEC	-0.17	0.47	-2.53***	0.000
LT	0.54	0.7	-4.85***	0.000
LUB	-3.5***	0.000	-10.01***	0.000

Table 4 presents the results of the Pedroni (2004) panel cointegration test using the log of EF and the other independent variables for the full sample as well as for the oil-producing countries and non-oil countries. The results show that for most of the tests, the within and between dimensions reject the null hypothesis of no panel cointegration at the 1 percent level.

Table 4: Pedroni cointegration tests

We perform the Pedroni (2004) panel cointegration test that accounts for country heterogeneity including the country size. Pedroni (2004) offers seven cointegration tests classified in two categories. The first is the "within dimension" tests, which involve four tests while the second category includes the "between dimension" tests which involve three tests. ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively.

	Within dimension				Between dimension		
	v-Stat	rho-Stat	PP-Stat	ADF-Stat	rho-Stat	PP-Stat	ADF-Stat
Full sample							
Statistic	0.33	-1.46*	-5.83***	-3.66***	-0.33	-7.42***	-3.57***
Weighted Statistic	-2.26	-2.48***	-7.55***	-3.55***			
Oil producing countries							
Statistic	0.15	-0.41	-3.14***	-2.46***	0.84	-4.53***	-2.01**
Weighted Statistic	-1.97	-1.34*	-4.81***	-2.13***			
Non-oil countries							
Statistic	1.82**	-2.63***	-6.59***	-2.22**	-1.37*	-6.4***	-1.88**
Weighted Statistic	1.03	-2.16**	-5.95***	-2.16**			

In addition to the PVAR estimation, we use the panel impulse response functions (IRFs) to capture the reaction of one variable in response to an innovation in another variable while keeping all other shocks equal to zero. To inspect the impulse response functions, it is necessary to estimate their confidence intervals, which were obtained using Monte Carlo simulations with 200 bootstraps. Moreover, we perform the variance decomposition to assess the accumulated percentage change in a variable that is explained by a shock to another variable. The results are discussed in Section 5 below.

5. Empirical results

We use the Generalized Method of Moments (GMM) to estimate the PVAR model in this paper. Table 5 reports the results for the full sample, the oil-producing countries, and the non-oil countries. When we estimate the PVAR system of equations, we particularly focus on the EF – HDI relationships to uncover any potential pathways and policy recommendations that can be implemented to achieve a sustainable development. With this in mind, Table 5 highlights several novel findings. Column 1 of Table 5 reveals that, for the full sample, a higher level of HDI affects negatively and significantly the ecological footprint. Accordingly, our results strongly suggest that a better human development is beneficial to the environment and appears to help reducing harmful emissions and mitigating any pressure on natural resources. To the knowledge of the authors, this result is novel and has not been documented in earlier literature. A possible explanation of this finding is that when a country develops by improving its levels of income, education, and healthcare services, the awareness of the importance of a safe and high-quality environment is improved. Hence, the negative relationship between EF and HDI.

Table 5: Estimation results for all, oil-producing and non-oil countries

Regressions are estimated for all, oil-producing and non-oil countries using the PVAR estimation technique. The dependent variable (d.EF) is the difference in log of ecological footprint. The independent variables are as described in Table 2. The stars ***, **, * refer to the 1, 5 and 10% levels of significance respectively.

	Full sample (MENA)	Oil-producing countries	Non-Oil Countries
	d.EF	d.EF	d.EF
d.EF(t-1)	-0.13**	-0.052	-0.40***
d.HDI(-1)	-5.73***	-7.38***	1.118***
d.EC(-1)	0.86***	1.41***	0.059
d.T(-1)	-0.03***	-0.034***	0.14***
d.UB(-1)	1.75***	2.04***	2.40***
Number of Observations	352	176	176

For the other control variables added to the model in column 1 of Table 5, we find that the first lag of energy consumption has a positive and significant impact on EF suggesting that a higher energy consumption leads to higher EF. This result is expected especially given the reliance of MENA region countries on non-renewable, highly pollutant, energy sources. The results in Table 5 highlight that the lag of trade has a negative impact on EF. Indeed, when international trade is particularly active, it allows the transmission of newer technologies that generate less harmful emissions (Nasir and Rehman, 2011; Churchill et al., 2018). Finally, the lagged value of urbanization loads positive in the full sample. It is now well-established that urbanization is often harmful to the environment given that pollution levels and industrial waste is much larger in urban areas adversely affecting the quality of the environment (Solarin et al., 2017; Lee, 2017). This is particularly true for the MENA region countries where, according the World Bank, around 65 percent of its population live in cities. This figure reaches more than 90 percent for several countries such as Qatar (99 percent) and Kuwait (100 percent). Additionally, urban populations put tremendous pressure on the available natural resources as they consume more goods and services compared to rural populations. This is alarming especially with the rapid increase in the urbanization of the world's population elsewhere.

To further investigate the relationship between EF – HDI, columns 2 & 3 of Table 5 present the estimation results for the oil-producing countries and the non-oil countries, respectively. We choose to split the sample in oil versus non-oil countries, as these groups are not homogeneous and have large disparities in terms of HDI levels. Hence, pooling their results together, as in column 1 of Table 5 may hide important variations. When we carefully inspect columns 2 & 3 in Table 5, several differences emerge between the two groups. First, the HDI affects negatively the EF in oil-producing countries but has a positive impact on the EF in the non-oil countries. This result is interesting and suggests that oil and non-oil countries may be at different levels of development affecting the impact of HDI on their EF. Following these lines of thoughts, our findings advocate that there may be a certain level of human socio-economic development after which the incremental effects of HDI on the environment reverse trend, thereby highlighting the existence of a nonlinear relationship between the HDI and the EF variables. We investigate thoroughly this potential nonlinear relation in subsection 5.3 below.

Second, the energy consumption is positively correlated with the EF in oil-producing countries (with an estimated coefficient of 1.41 significant at the 1 percent level), but has no significant impact on the EF variable in non-oil countries. Third, the trade has a negative impact on the current level of EF in oil-producing countries while its effect is positive in non-oil countries. A plausible explanation of this finding is that oil-producing countries are mainly exporters of oil and gas and importers of intermediate and final goods. Given, their large financial resources and the increasing awareness within these countries for the need of a better quality environment, their imports tend to include the latest innovations offering a lower energy consumption whereas non-oil countries are usually relying on conventional technologies that are more energy greedy. Finally, similar to the full sample results, the urbanization variable loads positive in both subsamples.

The analysis of the PVAR results reveals the existence of many variables affecting the EF. While the policymakers within a country have little control on trade, energy consumption, and urbanization to reduce pollution, they can focus on the HDI as a strong tool to achieve better socio-economic levels and engage in a sustainable development.

5.1 The variance decomposition analysis

The PVAR estimation results in Table 5 show the existence of a strong relationship between EF – HDI and suggest that this dependence may be nonlinear according to level of socio-economic development. To shed more light on the nature of this relationship, we now analyze the contribution of structural shocks affecting each endogenous variable. The results are reported in Table 6 below. The top row of Table 6 represents the variance decomposition of the EF resulting from its own shocks and form shocks to HDI, trade, energy consumption, and urbanization after 1 period whereas the third row reports the variance decomposition of EF at a 10 period horizon. The evidence shows that after 10 periods 49 percent of the overall variability in EF is explained by its own variations whereas 27% results from variations in HDI. Interestingly, HDI explains the variability in EF more than what trade (7 percent), energy consumption (13 percent), and urbanization (2 percent) can explain combined. Moreover, the evidence in Table 6 shows that HDI still plays a crucial role in explaining variations in EF even at a 10 periods horizon. The variance decomposition analysis corroborates therefore our main findings according to which there is a strong relationship between EF – HDI.

Table 6: Variance decomposition of the panel VAR model

We perform the variance decomposition to assess the accumulated percentage change in EF and HDI that is explained by a shock to the variable itself and to trade, energy consumption, and urbanization at a horizon of 1 period (top rows) and 10 periods (bottom rows), respectively.

	d.EF	d.HDI	d.T	d.EC	d.UB
Impulse variables at horizon 1					
d.EF	0.75	0.000	0.05	0.18	0.008
d.HDI	0.00	0.86	0.03	0.10	0.000
Impulse variables at horizon 10					
d.EF	0.49	0.27	0.07	0.13	0.021
d.HDI	0.007	0.83	0.032	0.11	0.009

5.2 The impulse response function results

To investigate further the existence of relations among the variables used in this study, we employ the Impulse Response Functions (IRFs). The IRF is a strong statistical tool to examine the response of a variable to one standard deviation change in another variable. Thus, IRF identifies the existence of a dynamic relationship between the selected variables. In this respect, the order of the variables in the system is highly important to estimate the PVAR model (Hamilton, 1994; Ouyang and Li, 2018; Liaqat, 2019). The common practice is to start form the most exogenous variables to the most endogenous variables (Ouyang and Li, 2018; Alsamara et al., 2019). In our empirical analysis, we assume that urbanization is more exogenous than trade, energy consumption, human development, and ecological footprint. This order implies the existence of a specific recursive structure in which a current shock in a variable affects the other variables contemporaneously, while the reverse impact occurs after a lag.

Accordingly, a sudden change in urbanization will influence trade, energy consumption, HDI and EF in the same year. Similarly, an unexpected shock in trade affects energy consumption, HDI and EF in the same year, but produces an effect on urbanization with a lag. Shocks to energy consumption will contemporaneously affect HDI and EF but will impact urbanization and trade with a lag. Finally, current shocks to HDI contemporaneously affect EF but their impact on urbanization, trade and energy consumption will happen with a lag. While all of the relationships are interesting, our focus in this paper is to uncover the response of EF to the other variables included in the model, and in particular to the HDI given our main goal to define potential pathways for sustainable development. The impulse analysis is carried out for the full sample of MENA countries (Figure 2) and for the two subgroups, namely the oil-producing countries and the non-oil countries (Figures 3 & 4).

Figure 2: Orthogonalized impulse-response functions of EF to one-standard error shock in HDI, trade, energy consumption, and urbanization for the full sample

We plot the panel impulse response functions (IRFs) for the full sample, which capture the reaction of EF in response to the innovation in HDI, trade, energy consumption, and urbanization, while keeping all other shocks equal to zero. To inspect the impulse response functions, we estimate their confidence intervals, which were obtained by using Monte Carlo simulations with 200 bootstraps.

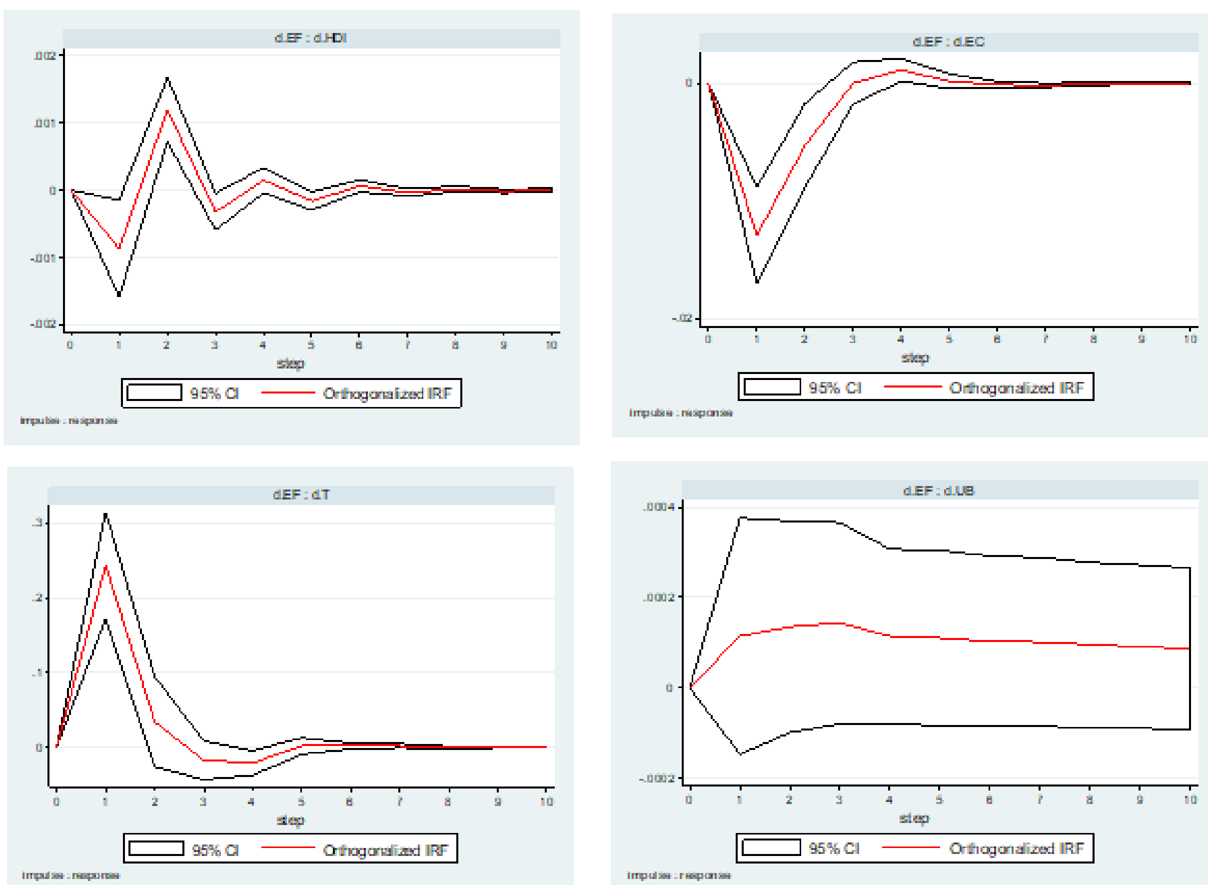


Figure 2 illustrates the response of EF to one standard deviations change in the HDI, trade, energy consumption, and urbanization over a period of ten years when the full sample of MENA countries is used. Figure 2 shows that a sudden shock in HDI exerts a negative response in EF in year 1 followed by a large positive response in year 2 that eventually dies out starting from year 3. This result suggests that there is an immediate response of EF to shocks in HDI confirming the existence of a relationship between the two variables.

We now review briefly the impact of the shocks of the other variables on EF for the full sample. The IRF indicates that shocks to trade will cause an increase in the EF that will vanish about 3 years later. Figure 2 also highlights that a one standard deviation shock to energy consumption will initially decrease the EF before quickly decaying and fading in about 4 years. Finally, the response of EF to a sudden shock in urbanization is statistically insignificant.

Figure 3 reports the response of EF to one standard deviations in HDI, trade, energy consumption, and urbanization for the subsample of oil-producing countries. Figure 3 results are mostly similar to the full smaple. In particualr, it provides evidence that a sudden shock in HDI leads to a positive effect on EF that vanishes after 5 years.

Figure 3: Orthogonalized impulse-response functions of EF to One-standard error shock in HDI, trade, energy consumption, and urbanization for the oil-producing countries

We plot the panel impulse response functions (IRFs) for the oil-prducing countries, which capture the reaction of EF in response to the innovation in HDI, trade, energy consumption, and urbanization, while keeping all other shocks equal to zero. To inspect the impulse response functions, we estimate their confidence intervals, which were obtained by using Monte Carlo simulations with 200 bootstraps.

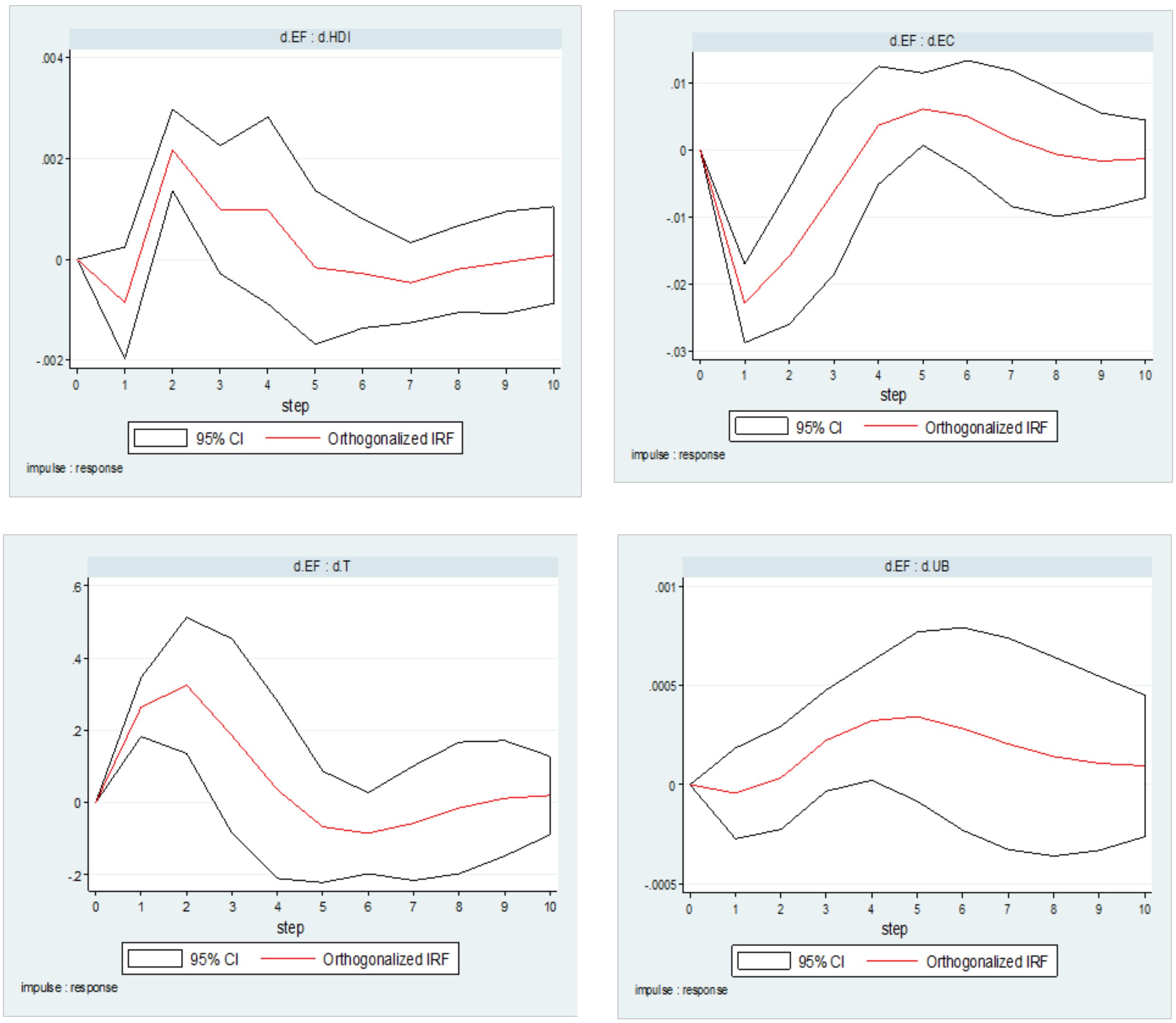
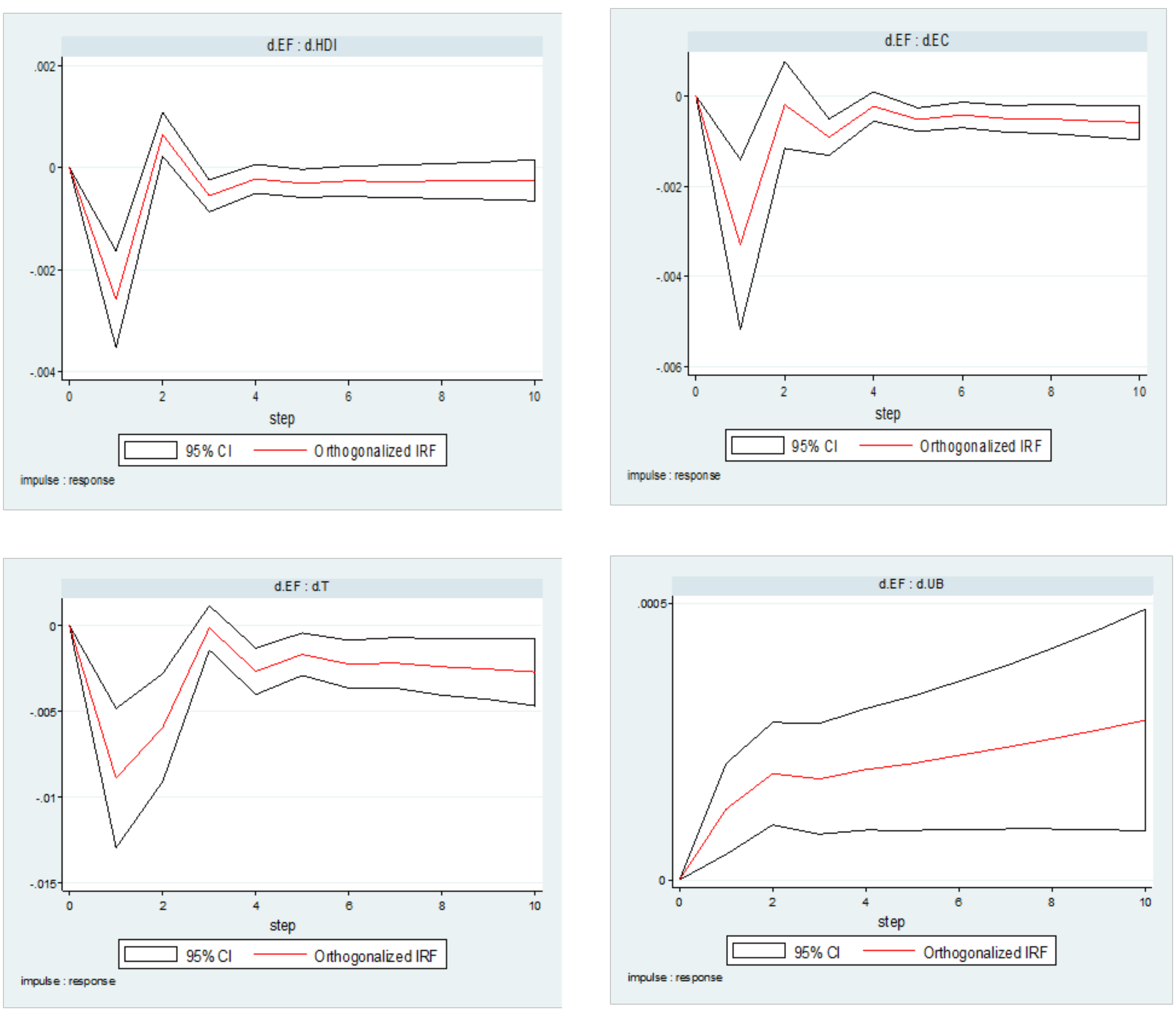


Figure 4 reports the reaction of EF to one standard deviation in HDI, trade, energy consumption, and urbanization for the subsample of non-oil countries. It is intresting to notice that the results for this group of countries are different from the full sample and the oil-producing countries.

Specifically, Figure 4 shows that a sudden shock in HDI, trdae, and energy consumption have a significant and negative impact on EF. These effects will progressively decay and vanish in about 3 years.

Figure 4: Orthogonalized impulse-response functions of EF to One-standard error shock in HDI, trade, energy consumption, and urbanization for the non-oil countries

We plot the panel impulse response functions (IRFs) for the non-oil countries, which capture the reaction of EF in response to the innovation in HDI, trade, energy consumption, and urbanization, while keeping all other shocks equal to zero. To inspect the impulse response functions, we estimate their confidence intervals, which were obtained by using Monte Carlo simulations with 200 bootstraps.



In sammary, the results of the PVAR, the varince decomposiotn, and the impulse response functions are pointing to the same conclusion according to which there is a strong relationship between EF – HDI. However, as shown in Table 5, this relationship is not monotonic and appears to depend on the level of development (nonlinear). We therefore explore in the subsequent section the exact nature of this relationship to draw important policy recommendations.

5.3 Testing the EKC hypothesis

A large number of papers have tested the EKC Hypothesis empirically and obtained mixed conclusions depending on the data used and the econometric technique employed. Within this literature, we use the HDI instead of income as a more comprehensive measure of economic development. We innovate by analyzing the impact of the 2011 Arab uprising on the relationship between the environment degradation and the economic development. Indeed, several years following the political turmoil in the region induced by the 2011 uprising, achieving the sustainable development goals in terms of environment, social, and economic prosperity remains a challenge. Lately, the political instability in many countries in the region has caused further degradation of the environment affecting considerably the ecosystems. However, as discussed in Section 2 above, the 2011 Arab uprising has improved the main indicators of human development in several MENA countries (See Figure 1).

Our contribution in this section is twofold. First, we investigate the initial results in Table 5 above suggesting that the relationship between EF – HDI may be nonlinear. Second, we study the effects of the 2011 uprising on this relationship. To do so and inspired by the literature on the EKC hypothesis, we estimate the relationship between EF and the HDI for the full sample and for the two subsamples using equation 2 below:

$$EF_{it} = \alpha_0 + \alpha_1 HDI_{it} + \alpha_2 HDI_{it}^2 + \epsilon_{it} \quad (2)$$

The effects of the 2011 Arab uprising are captured by including a dummy variable that takes the value of 1 after 2011, and 0 otherwise. We also include interactive terms equal to the HDI and HDI^2 variables multiplied by the 2011 dummy. These interactive terms capture the incremental effects of HDI after the 2011 uprising in the region.

$$EF_{it} = \beta_0 + \beta_1 HDI_{it} + \beta_2 HDI_{it}^2 + \beta_3 dum2011 + \beta_4 dum2011 * HDI_{it} + \beta_5 dum2011 * HDI_{it}^2 + \epsilon_{it} \quad (3)$$

Following the common practice, when these macroeconomic variables are employed, we examine the presence of long-run cointegration between the variables using the Pedroni (2004) test of cointegration which confirm the presence of a long-run relationship between all variables. To estimate the cointegrating vector, the literature has identified several estimation techniques that can be used. For instance, equations (2) and (3) may be estimated using the panel Dynamic OLS (DOLS) or the Fully Modified OLS (FMOLS) methodology introduced by Pedroni (2000, 2001). These techniques ensure that the regression estimates are not spurious, a common problem when the variables are non-stationary. However, the DOLS estimation technique has been criticized because of its inability to account for cross-sectional heterogeneity (Kao and Chiang; 2000). Hence, we use FMOLS in this paper as it is relatively more suitable for small samples and can be applied even in the presence of endogeneity and panel heterogeneity.

Table 7: Estimation results of the EF – HDI relationship for all, oil-producing, and non-oil countries

Regressions are estimated for all, oil-producing and non-oil countries. The dependent variable (LEF) is the log of the ecological footprint. The independent variables are as described in Table 2. Dum2011*HDI is the interactive term equal to the 2011 uprising dummy multiplied by the HDI. Dum 2011*HDI2 is the interactive term equal to the 2011 uprising dummy multiplied by $(HDI)^2$. TP is the turning point from equation 2. TP_BUP is the turning point without accounting for the 2011 uprising in equation 3 whereas TP_AUP is the turning point when we account for the 2011 uprising. The stars ***, **, * refer to the 1, 5 and 10% levels of significance respectively.

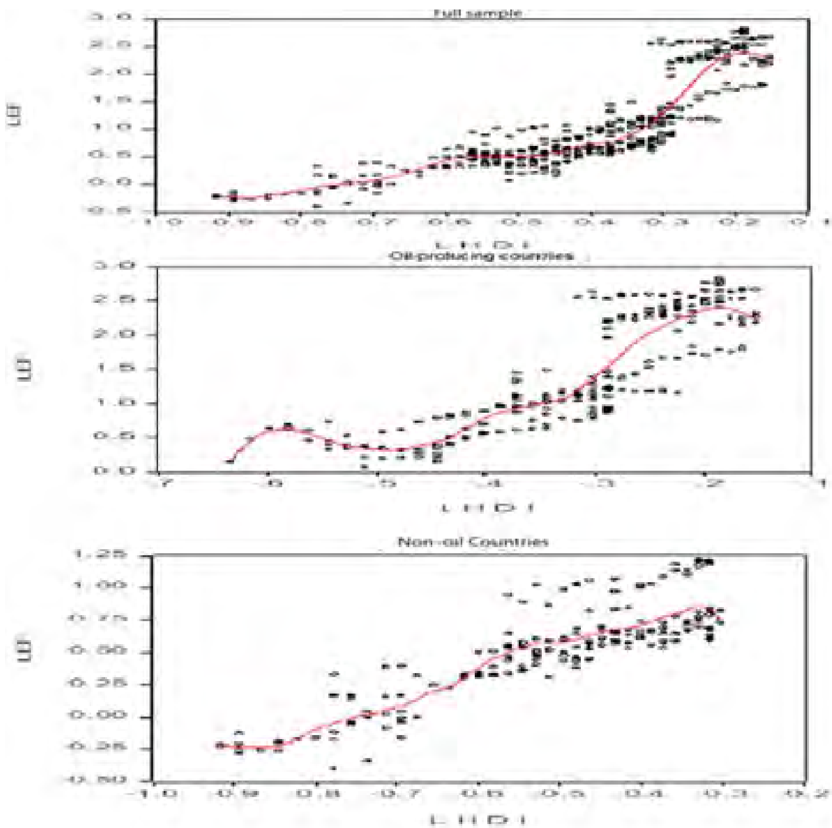
	Full sample (MENA)		Oil-producing countries		Non-Oil countries	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
LHDI	-4.61***	-2.44***	-13.00***	-10.76***	-3.70***	-4.00***
LHDI2	-5.26***	-4.80***	-23.92***	-19.59***	-4.75***	-5.53***
Dum 2011		-1.84***		1.17***		-0.01
Dum2001*HDI		1.87***		3.05***		-0.8***
Dum 2011*HDI2		2.46***		-3.80***		-1.2***
TP	0.64		0.76		0.68	
TP_BUP		0.77		0.75		0.69
TP_AUP		0.88		0.85		0.70
Mean of HDI by sample for 2016	0.71		0.79		0.63	

Table 7 presents the results for the full sample of MENA countries and for the two subsamples of oil and non-oil countries. Table 7 reveals the presence of an inverted U-shaped relationship that links EF to HDI. Indeed, prior to the 2011 uprising (dummy = 0 in equation 3 above), the turning point for the full sample occurs at a level of HDI equal to 0.77 (see Figure 5 – top Panel). The turning point is calculated as:

$$HDI^* = \exp\left(\frac{-\beta_1}{2\beta_2}\right)$$

Figure 5: The relationship between EF and HDI in the full sample, the oil-producing, and the non-oil countries

The top panel contains the scatterplot of the log of EF and the log of HDI for the full sample. It shows the existence of a turning point in the MENA countries full sample. The middle panel contains the scatterplot of the log of EF and the log of HDI for the oil-producing countries. It shows the existence of a turning point in oil-producing countries. The bottom panel contains the scatterplot of the log of EF and the log of HDI for the non-oil countries. It shows the existence of a turning point in the non-oil countries.



Accordingly, HDI improvements in the MENA region that remain below 0.77 will lead to environmental degradation. When countries attain a higher level of human development (above 0.77), further improvements in the HDI will result in environment enhancements. Hence, our findings suggest that countries within the MENA region can focus on improving their HDI to achieve a sustainable development. This result is novel and has not been documented in previous literature. The essence of this finding is that instead of focusing solely on income, as in the traditional EKC setup, countries can aspire to a comprehensive development where they concentrate on achieving higher income, stronger education, and longer life expectancy while enjoying a better environment. When we take into consideration the 2011 Arab uprising (dummy =1 in equation 3), Table 7 shows that the turning point in the full sample shifts upward to 0.88 due to political changes.

$$HDI^{*} = \exp\left(\frac{-(\beta_1 + \beta_4)}{2(\beta_2 + \beta_5)}\right)$$

This shift is statistically significant as both interactive terms are highly significant at the 1 percent level. According to this finding, after the 2011 uprising, countries would need to achieve a higher HDI to experience a better environment quality. Hence, the existence of a decoupling between EF and HDI that would slow down the convergence to the turning point and require more resources to attain environmental improvements.

When the results are analyzed by subgroup of countries, Table 7 reveals that for oil-producing countries, the turning point occurs at a lower level (0.75) compared to the full sample prior to the political uprising in the region when the dummy is set equal to 0 in equation 3 (see Figure 5 – middle Panel). However, when the uprising dummy and interactive terms are added, a different relation is revealed. For this group of oil-producing countries, the turning point shifts to around 0.85 and the shift is highly significant at the 1 percent level. Thus, oil-producing countries must significantly increase their HDI levels to start experiencing a reduction in the EF due to the political unrest.

The results are similar when the non-oil group of countries are considered. Prior to 2011, the level of the turning point was nearly 0.69 (See Figure 5 – bottom Panel). Due to the uprising, the turning point shifts to 0.70 and the change is statistically significant at the 1 percent level even though the difference is not economically large. These findings suggest that the 2011 Arab uprising did affect the EF – HDI relationship in this group of countries.

Overall, the results in Table 7 highlight that improving the HDI level will ultimately result in a better environment and that political instability may delay environmental benefits resulting from the socio-economic development.

It is also important to notice that if we ignore the crisis dummy and interactive terms and estimate equation 2, the turning points reported in Table 7 are different from those obtained when we control for the crisis in equation 3. Hence, ignoring the GFC may lead to misleading conclusions if policymakers assess their environmental achievements using equation 2 only.

As a last robustness exercise, we investigate the presence of the inverted U-shaped relationship for each individual country in the MENA region. Table 8 reports the results of the estimation of equations (2) and (3) for each individual country and displays the tuning points before the 2011 uprising as well as its level when the uprising is taken in to account. The results in Table 8 confirm our main conclusions in Table 7. With few exceptions, the level of the turning point shifts upward when we include the post 2011 period. Hence, the trend observed in Table 7 is not due to a pooled effect, but is rather true at the country level.

Table 8: Estimation results of the EF – HDI relationship for all, oil-producing, and non-oil countries

Regressions are estimated for all, oil-producing and non-oil countries. The dependent variable (LEF) is the log of the ecological footprint. The independent variables are as described in Table 2. Dum2011*HDI is the interactive term equal to the 2011 uprising dummy multiplied by the HDI. Dum 2011*HDI2 is the interactive term equal to the 2011 uprising dummy multiplied by $(HDI)^2$. TP_BUP is the turning point without accounting for the 2011 uprising whereas TP_AUP is the turning point when we account for the 2011 uprising. The stars ***, **, * refer to the 1, 5 and 10% levels of significance respectively.

	TP_BUP	TP_AUP	HDI	HDI^2	HDI_AUP	HDI^2_AUP	DUM_HDI	DUM_HDI^2	DUM2011
Algeria	0.73		-5.17***	-8.70***	-4.06***	-6.59***	-100.69	-179.24	-13.8
Bahrain	0.80		-19.19***	-39.8***	-21.81***	-50.76***	6.86	8.52	0.81
Iran	0.72	0.76	-7.92***	-13.55***	-2.75***	-4.28***	-28.00***	-50.41***	-3.95***
Iraq	0.52	0.67	-2.05***	-2.22***	-11.00***	-8.58***	-128.19**	-166.71***	-24.11**
Libya	0.66	0.71	-8.33***	-14.25***	-26.62**	-32.14*	-121.79***	-187.92***	-20.13***
Qatar	0.83	0.84	-27.22	-69.91	-26.23***	-66.45***	10.58*	15.28**	1.44***
Saudi Arabia	0.79	0.83	-16.93***	-42.13***	13.21***	28.25***	-80.92**	-203.85**	-8.16***
UAE	0.77		-20.59	-40.22	-20.43***	-39.56**	-6.64	-46.47	0.12
Jordan	0.55	0.82	-4.82***	-8.41***	10.44***	8.96***	-25.75***	-48.64***	-3.27***
Morocco	0.31	0.66	-2.46***	-2.90***	8.33***	3.65***	-50.27***	-55.44***	-13.23***
Sudan	0.37		-12.33***	-7.95***	-12.33***	-6.25***	69.18	46.77	25.28
Syria	0.56	0.79	-4.16***	-5.87***	12.74**	11.14**	-14.22	-14.29*	-3.57
Tunisia	0.69		-4.27***	-6.25***	-3.70***	-5.07***	-34.40	-55.86	-5.16
Turkey	0.66	0.72	-6.38***	-8.79***	-5.25***	-6.38***	-364.33**	-569.50***	-58.12***
Egypt	0.70	0.67	-3.71***	-5.43***`	-3.53***	-5.11**	-118.5**	-151.2**	-23.14**
Yemen	0.71		-0.42***	-0.75***	-0.74***	-1.11***	35.23	21.85	13.85

6. Conclusion and policy implications

This study highlights novel relationships between EF and HDI and reveals interesting findings for the full sample of MENA countries as well as for oil-producing and non-oil countries. It contributes to the existing literature in many ways. First, this paper employs the HDI instead of the GDP per capital to investigate potential pathways for a better environment. The HDI is a superior variable as it includes the social dimension considered as a pillar of sustainable development. Our results reveal that the ecological footprint is strongly impacted by the level of the human development index suggesting that policymakers are more likely to achieve a sustainable development when the HDI improves. This result is robust and has been established using the PVAR estimation, the variance decomposition, and the impulse response functions.

Second, we document different patterns between oil-producing and non-oil countries suggesting that these groups are at different levels of development and that the relationship EF – HDI is non-monotonic. Specifically, we show that there exists an inverse relationship between EF and HDI where environmental enhancements can only be attained beyond a certain level of HDI (turning point) without depleting and harming the natural resources.

We also find that other factors affect the environmental footprint including trade, energy consumption, and urbanization. While policymakers cannot efficiently manage trade, energy consumption, and urbanization to control pollution, our study reveals that improving the HDI is a viable policy tool and represents a step forward to sustainable development. Finally, the evidence shows that the 2011 Arab uprising has impacted the EF – HDI relationship by shifting its turning point upward. Thus, due to the uprising, MENA countries need a higher level of HDI to start experiencing environmental improvements. Political instability may therefore jeopardize the efforts of a country to attain the sustainable development goals.

It is important to notice that the importance of our study expands beyond the MENA countries as pollution and political instability, within a region possessing large reserves of non-renewable energy, may affect the neighboring countries and the world at large.

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